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System Performance Operational Risk Assessment Tool SPORAT

73rd MORSS
21-23 June 2005

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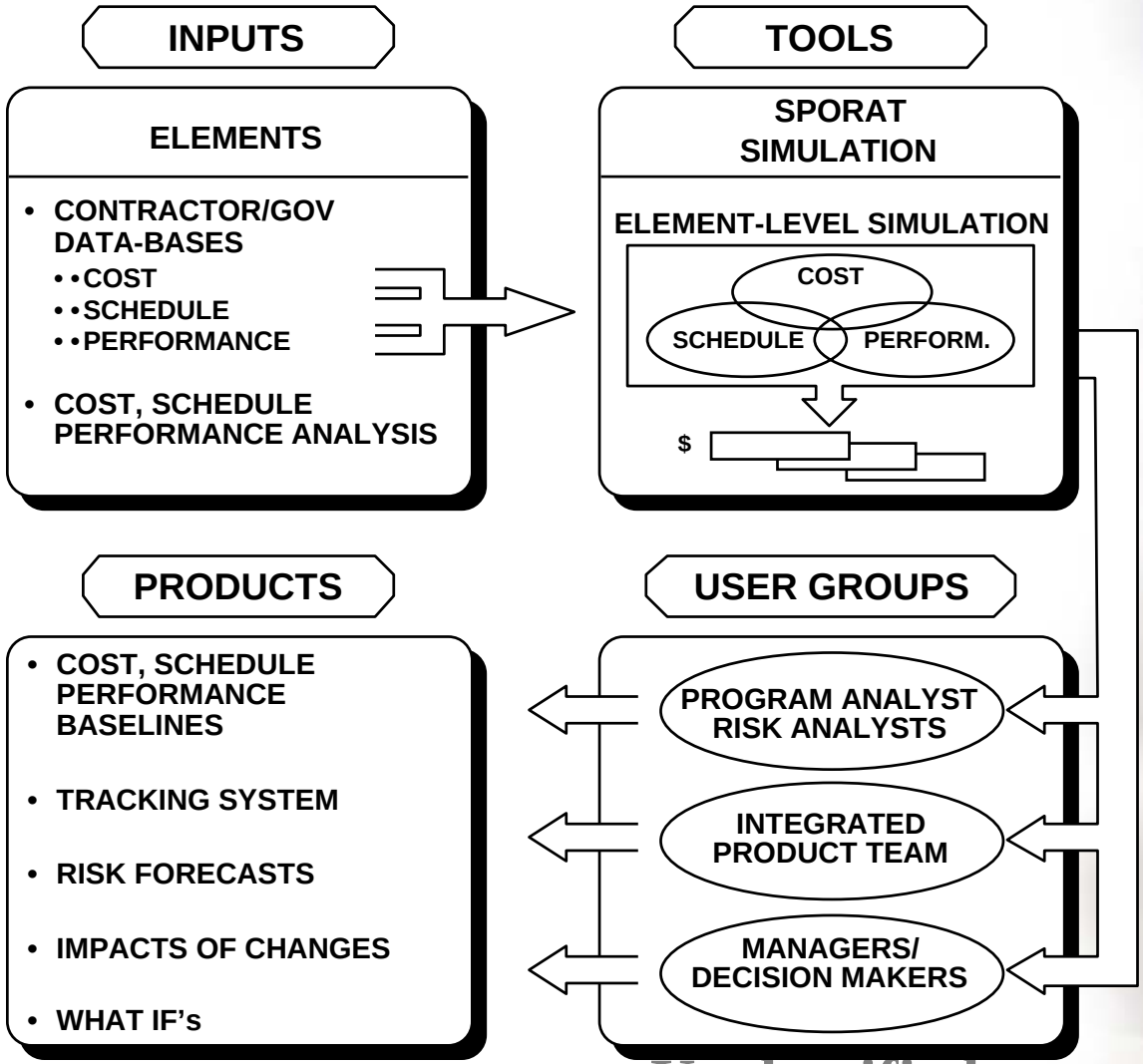
Purpose

- Performance as a variable in decision risk assessment
- Define the relationship of system availability from acquisition development to battlefield consequences.
- Define the cost risk methodology

System Performance Operational Risk Assessment Tool (SPORAT) Concept



SPORAT CAPABILITIES

COST CAN BE MODELED USING A WIDE RANGE OF DATA, BCE, PMA, CPR, ETC.

SCHEDULE CAN BE MODELED USING ARTEMIS, OPENPLAN, MACPROJECT PRO, AND MANY OTHERS.

PERFORMANCE IS DERIVED FROM TPMs, TRDs, ELEMENT SIMULATIONS (EADSIM, TACSIM, RADCAM, etc.), ACTUAL TEST DATA, EXPECTED TEST DATA, OR THEORETICAL ANALYSIS.

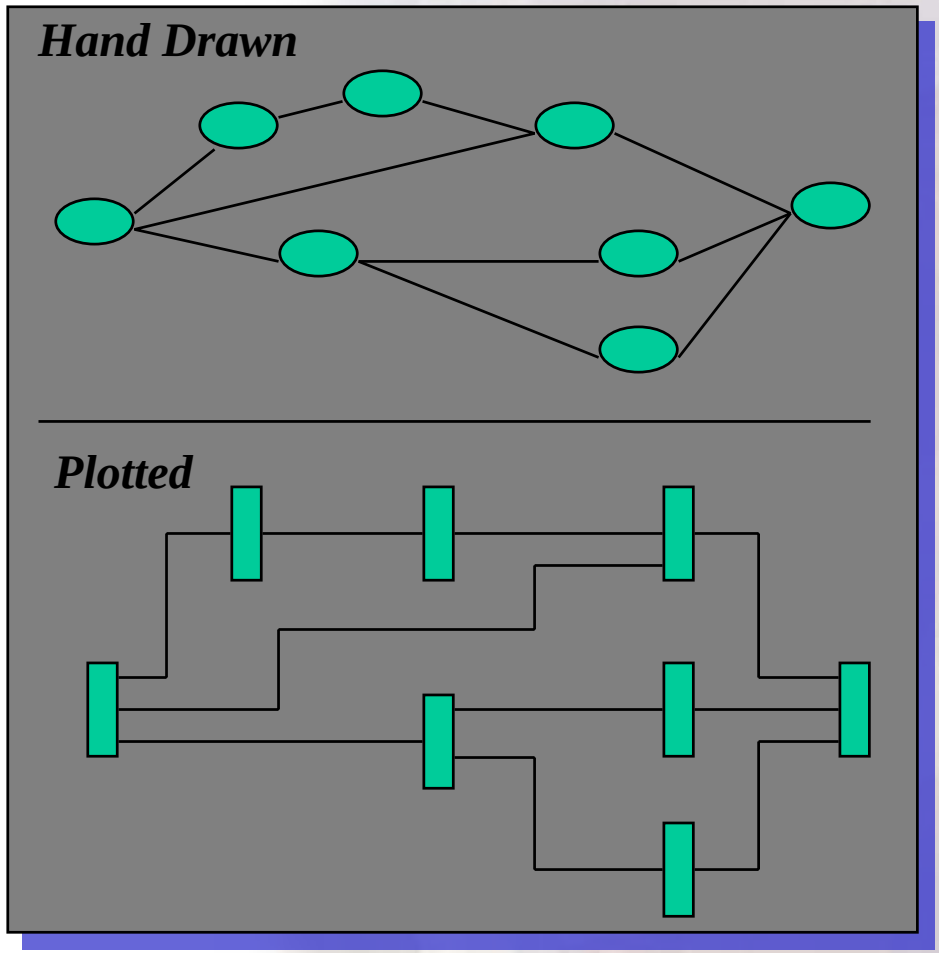
THE ***PROBLEM*** CAN BE MODELED AT ANY LEVEL FROM COMPONENT TO SYSTEM OR A COMBINATION OF VARIOUS LEVELS.

COST, SCHEDULE AND PERFORMANCE CAN BE REPRESENTED AS MATHEMATICAL FORMULAS OR PROBABILITY DISTRIBUTIONS OR A COMBINATION OF BOTH.

THE ***NETWORK LOGIC*** IS FLEXIBLE ENOUGH TO MODEL COMPLEX INTERRELATIONSHIPS SUCH AS TEST FAILURES, REDESIGN AND RETEST OF COMPONENTS OR SYSTEMS, THUS, PROVIDING THE PROBABLE TIME, COST AND SYSTEM PERFORMANCE ASSOCIATED WITH SUCH A FAILURE.

Network Development

- Logic network of project
- Initial development by benchmark
- Decomposition of benchmark activities
- Assignment of activity durations
- IPT quality review
- Input logic activities into SPORAT
- IPT final verification and validation



Overall TPP Matrix

TECHNICAL PERFORMANCE PARAMETER	APPLIED	CONDITIONS FOR DRAW	CONSEQUENCES IF A FAILURE OCCURS		
			TYPE	HARDWARE	SOFTWARE
TRACK FILE OBJECTS (NUMBER)	BM 0.5 N311-N370 BM 1.0 N591-N600 BM 2.0 N730-N731	NORMAL DISTRIBUTION MAX 200, MIN 1 BM 0.5 - MEAN 100, 3 SEC STD 10 BM 1.0 - MEAN 100, 3 SEC STD 10 BM 2.0 - MEAN 100, 3 SEC STD 5	REWORK REWORK		TIME & COST 5%-10% DIST. DIST. 35%-50%
TRACK UPDATE LATENCY (SECONDS)	BM 0.5 N465-N490 BM 1.0 N601-N602 BM 2.0 N740-N741		REWORK	15% HW COST HDWE INSTL TIME	TIME & COST 10%-20% DIST.
TRACK PURGE (SECONDS)	BM 1.0 N604-N605		REWORK		TIME & COST 35%-50%
MESSAGE HANDLING RATE (MSGS PER SEC)	BM 1.0 N652-N660	GAMMA DIST. R=2 MAX 50, MIN 5, 1 SEC MEAN 17 STD 12	REWORK	15% HW COST	TIME & COST 5%-10% DIST.
MESSAGE HANDLING LATENCY (SECONDS)	BM 1.0 N654-N655		REWORK		TIME & COST 10%-20% DIST.
C^2 PROCESSING		NORMAL DIST. MAX 200, MIN 100 MEAN 100 STD 30			

- *SOFTWARE REWORK NOT LESS THAN ONE DAY*
- *HARDWARE UPGRADE INCLUDES COST PLUS ONE WEEK DELIVERY DELAY*

How TPP's are Applied

- Tracked Objects Database
- Incoming Sensor Data Sets
- Designation of Objects to be Updated

→ **UPDATE OBJECT ASSIGNMENTS** →

- New Object-Data Association

- Accuracy of Correlations
- Number of Hits Needed for Correlation
- Correlation Cycle Timeline
- False Correlations
- Correctness of Correlation Thresholds
- Robustness in Utilization of Inaccurate or Incomplete Sensor Data
- Erroneous Object Updates
- Are Correlation Thresholds Being Met?
- Task Processing Timelines

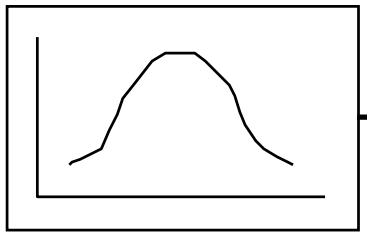
Technical Performance Parameter	Metric
• Accuracy of Object Correlations	• Percent of Correct Correlations
• Number of Hits Needed for Correlation	• Average Counts of Hits (#)
• Correlation Cycle Timeline	• Average Time

Application of TPPs

TRACK FILE OBJECTS (BM 0.5/1.0/2.0)

(1)

Normal Distribution



Mean = 100

SD = (30 / 10 / 5)

SDM Coding

Pass GE 100 Objects

Fail LT 100 Objects

Escape

	Cost	Time
0.5	5-10%	5-10%
1.0	35-50%	35-50%
2.0		

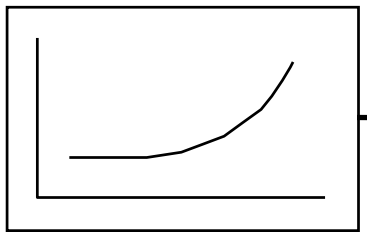
Fix: Uniform Distribution

Results

TRACK LATENCY (BM 0.5 / 1.0 / 2.0)

(2)

Logarithmic Function



Internal/ Integrated Testing

Pass GE 3 Sec Update

Fail LT 3 Sec Update

Escape

	Cost	Time
0.5	5-10%	5-10%
1.0	H/W	7 Days
2.0		

Fix: Uniform Distribution

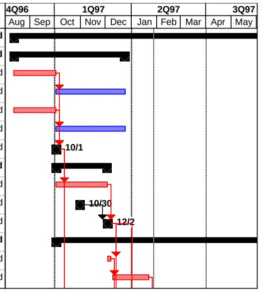
Software Integration Phase 5

Cost

Arc #	WBS	Description	Duration	From Node #	To Node #	Start Time	Finish Time	1	2	3	4	5	Total	Rate
160	25321	ENGAGEME	126	10	140	0	126	22.06	36.14	0.00	0.00	0.00	58.20	0.4619
170	25325	ENGAGEME	126	10	140	0	126	22.06	36.14	0.00	0.00	0.00	58.20	0.4619
180	25325	SW DEV. EN	126	10	140	0	126	22.06	36.14	0.00	0.00	0.00	58.20	0.4619
190	25311	CONFIGURA	126	10	140	0	126	302.00	75.27	0.00	0.00	0.00	377.27	2.9942
200		ENGAGEME	0	130	140	126	126	0.00	0.00	0.00	0.00	0.00	0.00	
220	25311	ENGAGEME	80	20	100	42	122	151.00	67.93	0.00	0.00	0.00	218.93	2.7366
230	25322	ENGAGEME	80	20	100	42	122	11.03	32.61	0.00	0.00	0.00	43.64	0.5455
240	25322	ENGAGEME	60	30	100	62	122	5.78	32.61	0.00	0.00	0.00	38.39	0.6398
250	**25333**	EXTERNAL	33	40	70	73	106	4.00	11.90	0.00	0.00	0.00	15.90	0.4818
260	25311	CAPABILITY	5	110	150	123	128	0.00	9.18	0.00	0.00	0.00	9.18	1.8358
270		ENGAGEME	0	150	170	128	128	0.00	0.00	0.00	0.00	0.00	0.00	
290	25312	TOP-LEVEL	40	50	220	99	139	0.00	53.24	16.80	0.00	0.00	70.04	1.751
300	25311	SW CAPABI	30	90	240	119	149	0.00	16.52	33.60	0.00	0.00	50.12	1.6707
310	25311	SW CAPABI	40	90	270	119	159	0.00	16.52	50.40	0.00	0.00	66.92	1.6731
320	25312	ENGAGEME	35	120	270	124	159	0.00	7.34	50.40	0.00	0.00	57.74	1.6498
330	25311	BASELINED	1	160	190	128	129	0.00	0.00	0.00	0.00	0.00	0.00	0
340	25311	INFORMATI	30	180	270	129	159	0.00	0.00	50.40	0.00	0.00	50.40	1.68
350	25311	ENGAGEME	5	250	270	154	159	0.00	0.00	8.40	0.00	0.00	8.40	1.68
360		ENGAGEME	*0*	*270*	*280*	*160*	*160*	0.00	0.00	0.00	0.00	0.00	0.00	
380	**25322**	ADA95 "PRI	45	60	230	103	148	0.00	22.03	22.80	0.00	0.00	44.83	0.9963
390	25322	ENGAGEME	90	130	350	126	216	0.00	1.76	50.40	69.34	22.81	144.32	1.6035
400	25322	DATA CLAS	100	80	350	116	216	0.00	10.58	50.40	69.34	22.81	153.13	1.5313
410	25322	PEER/CODE	80	210	350	136	216	0.00	0.00	42.00	69.34	22.81	134.15	1.6769
420	25322	CODED DAT	80	210	350	136	216	0.00	0.00	42.00	69.34	22.81	134.15	1.6769
430		ENGAGEME	*0*	*350*	*360*	*217*	*217*	0.00	0.00	0.00	0.00	0.00	0.00	
450	25326	INTEGRATI	30	200	290	132	162	0.00	0.00	36.00	0.00	0.00	36.00	1.2
460	25326	DATA CLAS	80	260	450	159	239	0.00	0.00	14.40	69.34	547.40	631.15	7.8894
470	25326	TEST WALK	5	410	440	234	239	0.00	0.00	0.00	0.00	114.04	114.04	22.809
480		ENGAGEME	0	450	460	239	239	0.00	0.00	0.00	0.00	0.00	0.00	
500	25333	ENGAGEME	60	90	310	119	179	0.00	5.10	107.14	4.71	0.00	116.96	1.9493
510	25333	ENGAGEME	65	300	380	164	229	0.00	0.00	17.86	28.29	19.65	65.79	1.0122
520	25325	ENGAGEME	40	320	390	189	229	0.00	0.00	0.00	41.28	319.32	360.60	9.0149
530	**25311**	ENGAGEME	50	340	490	209	259	0.00	0.00	0.00	90.00	193.06	283.06	5.6612
540	25333	ENGAGEME	10	400	420	229	239	0.00	0.00	0.00	0.00	14.03	14.03	1.4034
550	25333	BMC2 TEST	30	400	490	229	259	0.00	0.00	0.00	0.00	42.10	42.10	1.4034
560	25333	ENGAGEME	25	410	490	234	259	0.00	0.00	0.00	0.00	35.08	35.08	1.4034
570	25333	ENGAGEME	10	430	470	239	249	0.00	0.00	0.00	0.00	14.03	14.03	1.4034
580	**25311**	CAPABILITY	5	480	490	254	259	0.00	0.00	0.00	0.00	21.94	21.94	4.3878
590		ENGAGEME	0	490	500	259	259	0.00	0.00	0.00	0.00	0.00	0.00	

Schedule

ID	Task Name	Duration
1	**Capability Increment 2 (CI-2)**	**405d**
2	**Site BM/C3 Design & Engineering**	**96d**
3	CI-2 Site Requirements Plan	37d
4	Site Requirements Maintenance	59d
5	Site IF Design Described in IDD	37d
6	Site IDD Maintenance	59d
7	CI-2 IR	0d
8	**CI-2 Software Design**	**44d**
9	Software Design	44d
10	1st Draft DWT Package Complete	0d
11	CI-2 DWTs Complete	0d
12	**Software Implementation**	**217d**
13	Software Implementation Phase I	4d
14	Software Implementation Phase II	31d



Performance

CDRL	Description	Submission Date	Frequency	Gov't Review
A001	Contract Funds Status Report	25 calendar days after end of accounting quarter	Quarterly	
A002	Cost Performance Report (CPR) - No Criteria	20 calendar days after end of accounting month	Monthly	
A003	Cost Performance Report (CPR)	10 calendar days after end of accounting month	Monthly	
A004	Funds & Man-Hour Expenditures Report	Deleted	N/A	N/A
A005	Data Accession List/Internal Data	30 days after contract award	Quarterly	N/A
A006	Master Integrated Program Schedule	11/30/96	Monthly	
A007	BMD Review/Working Group Agendas	2 weeks prior to each PMR	Bi-monthly	
A008	TMD System Description Document	6/28/96	Annually	45 days
A009	TMD C3I Interface Description Document	1/29/96	As Req.	45 days
A010	TMD Interoperability/Integration Roadmap	Deleted	N/A	N/A
A011	TMD Integrated Test Plan	1/31/96	Annually; 30 days post TMD Capstone TEMP or 90 days prior to first Integration test	
A012	TMD Integrated Test Design & Assessment Plan	3/2/96 (30 days after submittal of A011)	30 days after submittal of A011	45 days

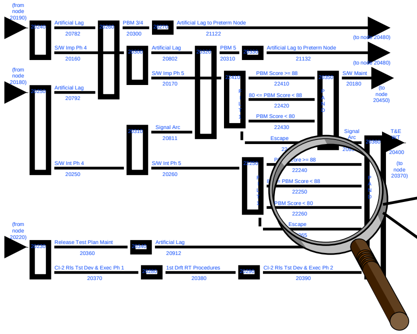
Planning	Coding	Testing

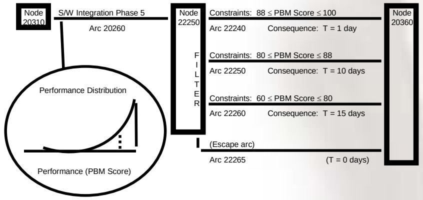
CI-1

CI-2

Planning	Coding	Testing

Software Integration Phase 5





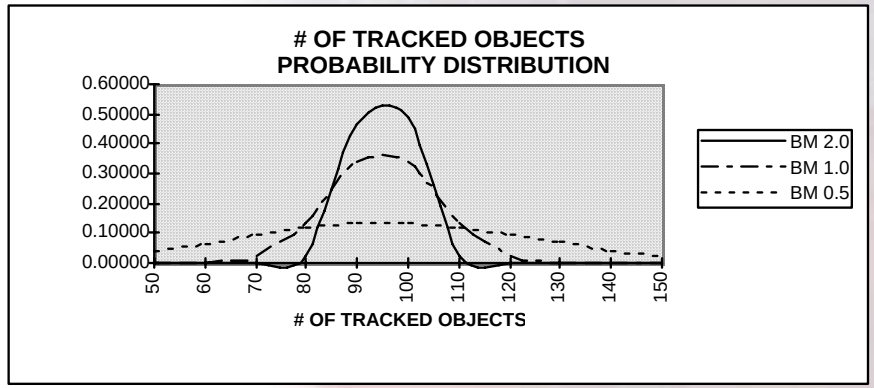
- Performance Distribution
- Filter Logic w/Consequences
- 1000 Iterations

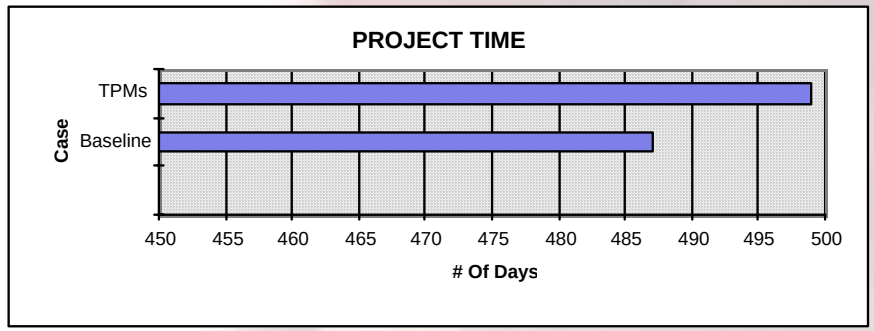
Unclassified

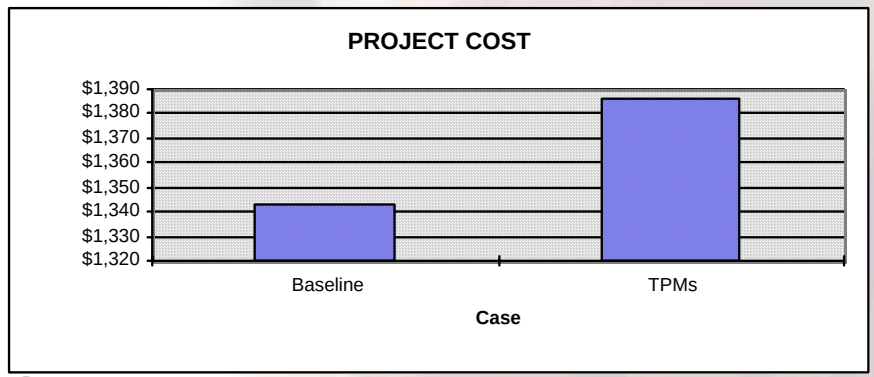
Tracked Objects Technical Performance

Analysis Steps

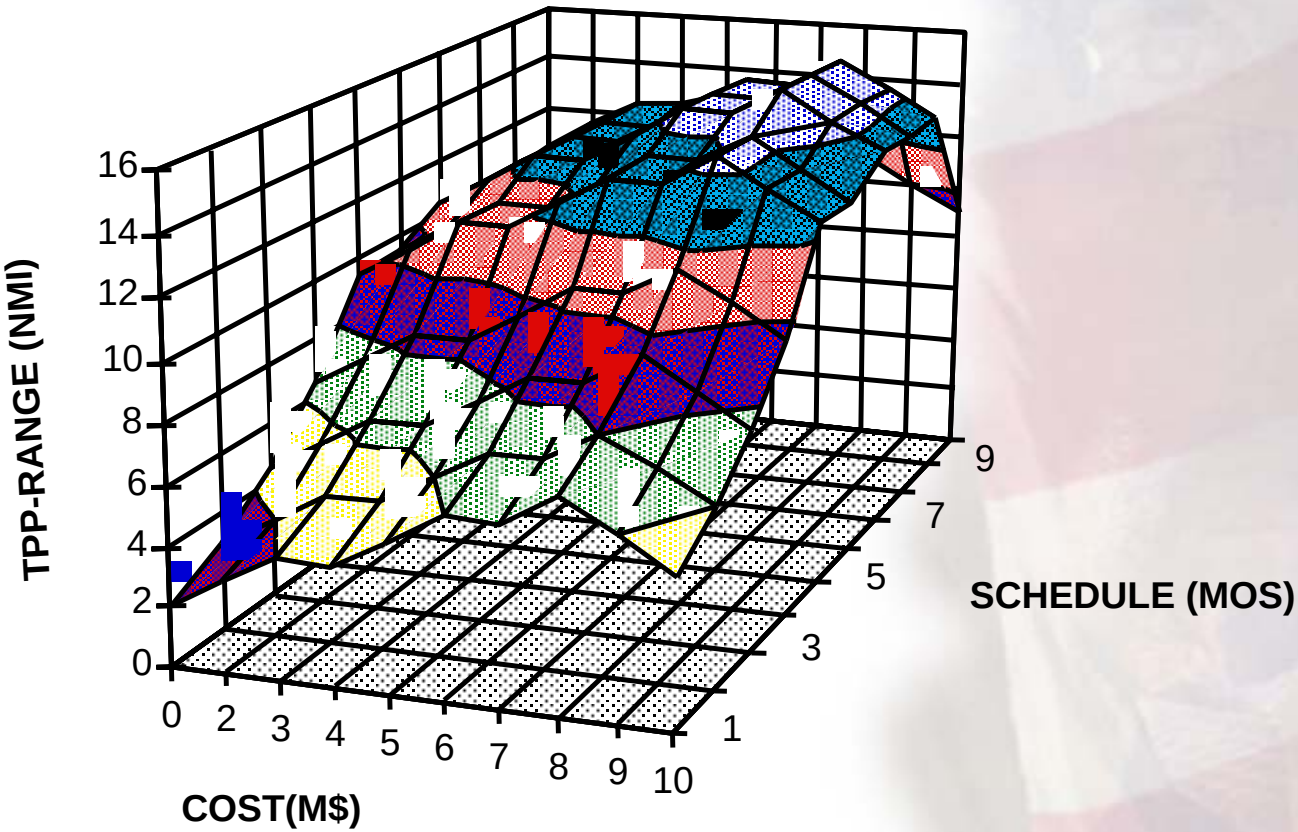
- **Developed Baseline Network**
- **Strategically Placed Technical Performance Distributions at Appropriate Benchmark Activities**
- **Developed and Analyzed Pass/Fail Performance Criteria**
- **Accumulated Progressive Technical Performance With Narrowed Distributions**
- **Assessed Cost/Schedule/Technical Performance**
- **Produced Graphical Results for Cumulative Risk Functions**







3D Dynamics of Cost, Schedule & Performance Risk



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Approach to Software Development Program

For Each Increment Build:

Req Def.

Gov works w/ Cont to:

- Define Inc Objectives
- Trace to TPM's/ SE Req
- Define Pre-demo Chk List
- Verify Executability
  - Understand:
    - Objectives
    - Tasks
    - Resources Req'd
- Assess Cont Plan *"Can it work ?"*

Design & Code

Gov :

- Understands tech details
- Guide issue resolution
- Doc decisions
- Track issue resolution

Int & Test

Gov :

- McCabe Tool (or equiv)
- Witness key testing

Pre-demo Test :

- Informal
- Verity Chk List
- Eng Lvl

Pre-Demo

Demo

Demo:

- Cont & Gov share in tech briefing
- Show traceability: TPMs/ SE Req to Chk List, Demo
- "Score Card"
- Development Performance:
  - S/W Metrics
  - Defects Removed
  - S/W Rel, Maint.
  - Issue Resolution

Key to Success ... realistic ... actuals ... DTC focus !!

Start S/W Metrics Foundation . . . . . Cont to grow S/W Metrics Data Base ... Goal: Calibrate our IPT to support Inc Build Executability Verification

Wkly Status | Wkly Status | Wkly Status | ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ | Wkly Status

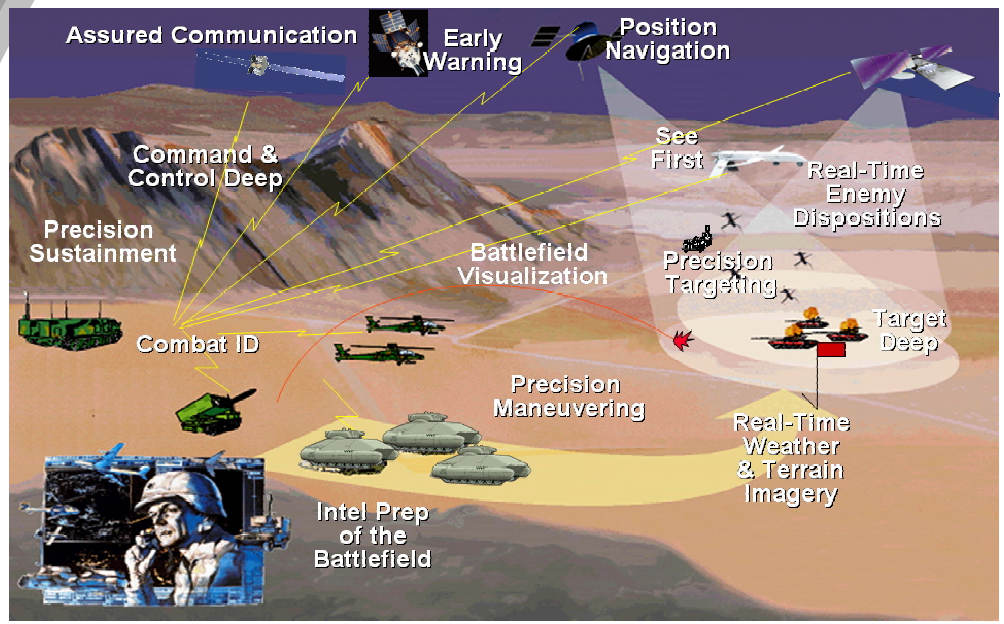
TPP/TPM Integrated Assessment Capabilities

- **Technical Design Minimums**
  - **Design goal achieved**
  - **What resources**
  - **Probability of goal**
  - **Cost impact**
- **Track Purge Applied**
  - **Resources need**
  - **Could the goal have been met**
  - **Better probability of success**
- **Deobligation of Funds**
  - **Least affected**
  - **Completion Affected**
  - **Achievement of next event**

- Windfall Funds
  - Acceleration of tasks
  - New technical goals
- New Requirement
  - Evaluate costs
  - Impact on original schedule
- Network Path Analysis
  - Time slices
  - Probability of success
- Technical Goal Not Achievable
  - What resources needed
  - What-ifs

System Operational Availability

Technical Risk & Logistics Analysis



- Performance Risk Identification /Mitigation
- System Maintenance Concept
- Weapon System Concept Trades
- Sensor vs. Interceptor Trades
- Supportability Design Criteria
- Cost

Battlefield Simulation

Logistics

Program Cost Schedule Performance

Life Cycle Cost/ Contractor

Unclassified

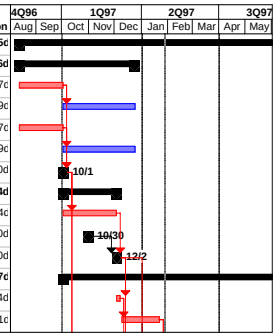
Radar Cost/Schedule/Performance

Contract Cost

Arc #	WBS	Description	Duration	From Node #	To Node #	Start Time	Finish Time	1	2	3	4	5	Total	Ratio
180	25321	ENGAGEME	126	93	140	0	126	22.09	36.14	0.00	0.00	0.00	58.20	0.4619
110	25324	ENGAGEME	126	93	140	0	126	22.09	36.14	0.00	0.00	0.00	58.20	0.4619
180	25325	SW DEV_ER	126	93	140	0	126	22.09	36.14	0.00	0.00	0.00	58.20	0.4619
190	25311	CONFIGURA	126	93	140	0	126	360.00	75.27	0.00	0.00	0.00	377.27	2.9943
200		ENGAGEME	0	139	140	126	126	0.00	0.00	0.00	0.00	0.00	0.00	
220	25311	ENGAGEME	80	37	101	42	122	151.04	67.82	0.00	0.00	0.00	218.93	2.7369
200	25322	ENGAGEME	80	40	100	42	122	11.00	32.43	0.00	0.00	0.00	43.64	0.5455
240	25322	ENGAGEME	60	30	100	40	120	9.78	32.43	0.00	0.00	0.00	38.30	0.6386
250	25331	EXTERNAL	30	40	70	40	100	4.00	11.96	0.00	0.00	0.00	15.96	0.4816
260	25311	CAPABILITY	5	122	150	123	128	0.00	9.18	0.00	0.00	0.00	9.18	1.8356
210		ENGAGEME	0	139	150	128	128	0.00	0.00	0.00	0.00	0.00	0.00	
290	25312	TDP-LEVEL	40	93	200	89	129	0.00	53.16	16.80	0.00	0.00	70.04	1.751
300	25311	SW CAPABI	30	93	240	129	149	0.00	16.53	33.65	0.00	0.00	50.12	1.6707
310	25311	SW CAPABI	40	93	270	113	153	0.00	16.53	50.40	0.00	0.00	66.92	1.6731
320	25312	ENGAGEME	35	93	270	134	169	0.00	7.34	50.40	0.00	0.00	57.74	1.6497
330	25311	BASELINES	1	169	190	129	129	0.00	0.00	0.00	0.00	0.00	0.00	0
340	25311	INFORMATI	30	180	270	129	159	0.00	0.00	50.40	0.00	0.00	50.40	1.68
350	25311	ENGAGEME	5	250	270	154	159	0.00	0.00	8.40	0.00	0.00	8.40	1.68
360		ENGAGEME	0	270	280	160	160	0.00	0.00	0.00	0.00	0.00	0.00	
380	25322	ADAB TRD	45	60	230	103	148	0.00	22.03	22.84	0.00	0.00	44.83	0.9963
390	25322	ENGAGEME	90	130	350	125	215	0.00	1.78	50.40	69.34	22.81	144.32	1.6035
400	25322	DATA CLAS	100	90	350	118	218	0.00	10.58	50.40	69.34	22.81	153.13	1.5313
410	25323	PERFORCOE	80	230	350	138	218	0.00	0.00	42.00	69.34	22.81	134.15	1.6769
420	25322	CODED DA	80	230	350	139	219	0.00	0.00	42.00	69.34	22.81	134.15	1.6769
430		ENGAGEME	0	350	360	217	217	0.00	0.00	0.00	0.00	0.00	0.00	
450	25326	INTEGRATE	30	300	290	132	162	0.00	0.00	36.00	0.00	0.00	36.00	1.2
460	25326	DATA CLAS	80	260	450	158	238	0.00	0.00	14.40	69.34	347.40	831.15	7.8894
470	25326	TEST WALK	5	430	440	234	239	0.00	0.00	0.00	0.00	114.04	114.04	22.809
480		ENGAGEME	0	450	460	239	239	0.00	0.00	0.00	0.00	0.00	0.00	
500	25331	ENGAGEME	60	90	310	110	170	0.00	5.82	107.14	4.73	0.00	116.96	1.9493
510	25331	ENGAGEME	65	320	380	164	229	0.00	0.00	17.86	28.29	19.65	65.79	1.0121
520	25325	ENGAGEME	40	300	360	189	229	0.00	0.00	41.86	169.32	360.60	571.78	14.295
530	25311	ENGAGEME	50	340	490	209	259	0.00	0.00	0.00	90.00	193.06	283.06	5.6612
540	25331	ENGAGEME	10	450	490	229	239	0.00	0.00	0.00	0.00	14.03	14.03	1.4034
550	25331	BASIC TEST	30	460	490	229	259	0.00	0.00	0.00	0.00	42.10	42.10	1.4034
560	25331	ENGAGEME	20	410	490	234	254	0.00	0.00	0.00	0.00	15.09	15.09	1.4034
570	25331	ENGAGEME	10	430	470	239	249	0.00	0.00	0.00	0.00	14.03	14.03	1.4034
580	25311	CAPABILITY	5	480	490	254	254	0.00	0.00	0.00	0.00	21.04	21.04	4.3878
590		ENGAGEME	0	490	500	254	254	0.00	0.00	0.00	0.00	0.00	0.00	

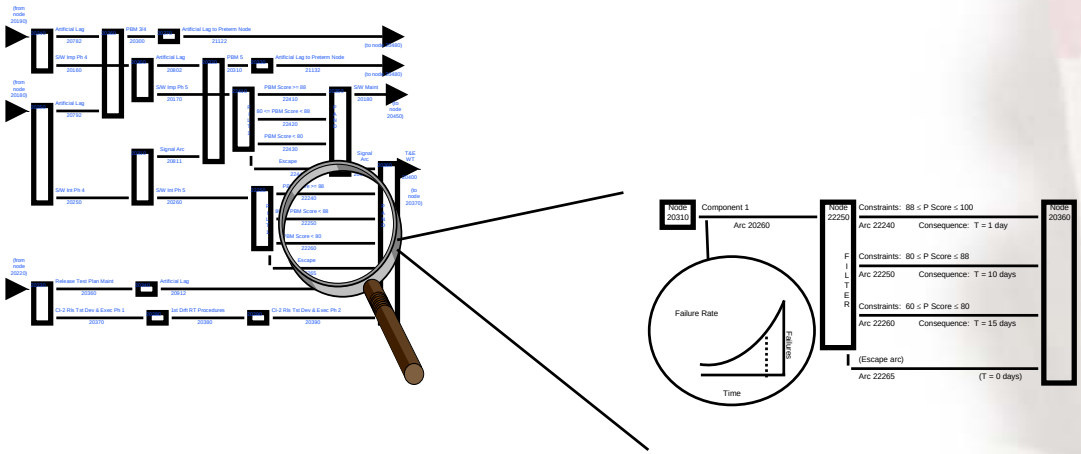
Contractor Schedule

ID	Task Name	Duration
1	**Capability Increment 2 (CI-2)**	405d
2	**Site BM/C3 Design & Engineering**	96d
3	CI-2 Site Requirements Plan	37d
4	Site Requirements Maintenance	59d
5	Site IF Design Described in IDD	37d
6	Site IDD Maintenance	59d
7	CI-2 IR	0d
8	**CI-2 Software Design**	44d
9	Software Design	44d
10	1st Draft DWT Package Comple	0d
11	CI-2 DWTs Complete	0d
12	**Software Implementation**	217d
13	Software Implementation Phase	4d
14	Software Implementation Phase	31d



Component Failure Rates

CDRL	Description	Submission Date	Frequency	Gov't Review
A001	Contract Funds Status Report	25 calendar days after end of accounting quarter	Quarterly	
A002	Cost Performance Report (CPR) - No Criteria	20 calendar days after end of accounting month	Monthly	
A003	Cost Performance Report (CPR)	10 calendar days after end of accounting month	Monthly	
A004	Funds & Man-Hour Expenditures Report	Deleted	N/A	N/A
A005	Data Accession List/Internal Data	30 days after contract award	Quarterly	N/A
A006	Master Integrated Program Schedule	11/30/96	Monthly	
A007	BMD Review/Working Group Agendas	2 weeks prior to each PMR	Bi-monthly	
A008	TMD System Description Document	6/28/96	Annually	45 days
A009	TMD C3I Interface Description Document	1/29/96	As Req.	45 days
A010	TMD Interoperability/Integration Roadmap	Deleted	N/A	N/A
A011	TMD Integrated Test Plan	1/31/96	Annually; 30 days post TMD Capstone TEMP or 90 days prior to first Integration test	
A012	TMD Integrated Test Design & Assessment Plan	3/2/96 (30 days after submittal of A011)	30 days after submittal of A011	45 days



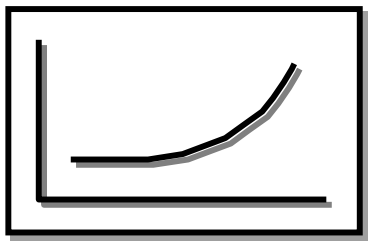
- Failure Distribution
- Filter Logic w/Consequences
- 1000 Iterations

Unclassified

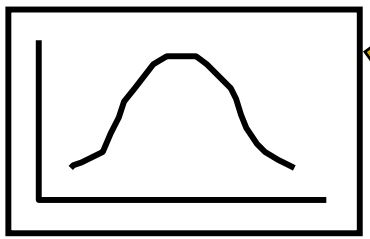
Radar Operational Availability Battlefield Environment

37% decrease in total LRU failure rate
9% decrease in Sustainment Cost
12% decrease in Leakers

Component Failure Rate



Component Cost



Sustainment Simulation

LOGAM

System Operational Availability
System Sustainment Cost

Battlefield Simulation

TACSIM → **LEAKERS**

Unclassified